

AMENDMENTS TO THE CLAIMS

Claim 1 (Original) A plating apparatus comprising:

an electrode head having an anode, a plating solution impregnated material for holding a plating solution, and a porous contact member which is brought into contact with a surface of a substrate;

a cathode electrode which is brought into contact with the substrate to supply current to the substrate;

a pressing mechanism for pressing said porous contact member of said electrode head against the surface of the substrate under a desired pressure;

a power source for applying plating voltage between said anode and said cathode electrode; and

a control unit for correlating and controlling the state of pressing said porous contact member of said electrode head against the surface of the substrate, and the state of plating voltage applied between said anode and said cathode electrode.

Claim 2 (Original) A plating apparatus according to claim 1, wherein said porous contact member is formed by polyethylene, polypropylene, polyamide, polycarbonate, polyimide, silicon carbide, or alumina.

Claim 3 (Original) A plating apparatus according to claim 1, wherein said plating solution impregnated material is formed by ceramics or porous plastics.

Claim 4 (Original) A plating apparatus according to claim 1, wherein at least a surface of said porous contact member which contacts the surface of the substrate is formed by an insulator or a material having high insulation properties.

Claim 5 (Original) A plating apparatus according to claim 1, wherein said control unit controls so as to cause at least one of said porous contact member and the substrate to rotate on its own axis or rotate on an axis spaced from said own axis.

Claim 6 (Original) A plating apparatus comprising:

a substrate stage for holding a substrate;

a cathode unit having a seal member for hermetically sealing a peripheral portion of a surface, to be plated, of the substrate by contacting the peripheral portion of the surface, to be plated, of the substrate held by said substrate stage, and a cathode electrode which is brought into contact with the substrate to supply current to the substrate;

an electrode head disposed above said cathode unit so as to be movable up and down and having an anode and a porous member with water retentivity at upper and lower parts of said electrode head;

a plating solution supply unit for supplying a plating solution between said anode and the surface, to be plated, of the substrate held by said substrate stage;

a pressing and separating mechanism for pressing said porous member against the surface, to be plated, of the substrate held by said substrate stage under a desired pressure and separating said porous member from the surface to be plated; and

a power source for applying plating voltage between said cathode electrode and said anode.

Claim 7 (Original) A plating apparatus according to claim 6, further comprising a relative movement mechanism for moving the substrate held by said substrate stage and said electrode head relative to each other.

Claim 8 (Original) A plating apparatus according to claim 7, wherein said relative movement mechanism comprises a rotating mechanism for rotating at least one of said substrate stage and said electrode head.

Claim 9 (Original) A plating apparatus according to claim 8, further comprising a torque sensor for detecting a rotating torque which is imparted when at least one of said substrate stage and said electrode head is rotated.

Claim 10 (Original) A plating apparatus according to claim 6, wherein said pressing and separating mechanism has an air bag for pressing said porous member against the substrate by expansion and contraction with gas pressure.

Claim 11 (Original) A plating apparatus according to claim 10, wherein said air bag is configured to contact said anode or said porous member and to move said anode or said porous member up and down in a horizontal state.

Claim 12 (Original) A plating apparatus according to claim 6, wherein said porous member has a multi-layered structure in which at least two kinds of porous materials are laminated.

Claim 13 (Original) A plating apparatus according to claim 6, wherein said electrode head has a housing which houses said anode and said air bag therein, and defines an anode chamber by closing a lower open end portion of said housing with said porous member.

Claim 14 (Original) A plating apparatus according to claim 13, wherein said anode chamber has a cylindrical shape.

Claim 15 (Original) A plating apparatus according to claim 13, wherein a gas introduction pipe communicating with said air bag, a plating solution introduction pipe for introducing the plating solution into said anode chamber, and a power supply port for supplying power to said anode are attached to said housing.

Claim 16 (Original) A plating apparatus according to claim 13, wherein said pressing and separating mechanism has an air bag for moving said housing up and down.

Claim 17 (Original) A plating apparatus according to claim 13, further comprising a vibrating mechanism for vibrating said housing or said substrate stage up and down, from side to side, or in a circle.

Claim 18 (Original) A plating apparatus according to claim 13, further comprising a temperature control mechanism for controlling a temperature of the plating solution in said anode chamber, and a temperature of the plating solution between said anode and the surface, to be plated, of the substrate held by said substrate stage.

Claim 19 (Original) A plating apparatus according to claim 6, wherein said substrate stage is configured to attract the backside surface of the peripheral portion of the substrate placed on the upper surface of said substrate stage and hold the substrate horizontally, and to pressurize the reverse side of the substrate by a fluid.

Claim 20 (Original) A plating apparatus according to claim 6, further comprising a vibrating mechanism for vibrating the substrate held by said substrate stage or said porous member.

Claim 21 (Original) A plating apparatus comprising:

- a substrate stage for holding a substrate;

- a cathode unit having a seal member for hermetically sealing a peripheral portion of a surface, to be plated, of the substrate by contacting the peripheral portion of the surface, to be plated, of the substrate held by said substrate stage, and a cathode electrode which is brought into contact with the substrate to supply current to the substrate;

- an electrode head disposed above said cathode unit so as to be movable up and down and having an anode and a porous member with water retentivity at upper and lower parts of said electrode head;

- a plating solution supply unit for supplying a plating solution between said anode and the surface, to be plated, of the substrate held by said substrate stage;

- a pressing mechanism for pressing said porous member against the surface, to be plated, of the substrate held by said substrate stage under a desired pressure; and

- a power source for applying plating voltage between said cathode electrode and said anode;

- a plating solution removing mechanism for removing the plating solution existing in a gap between said porous member and the surface, to be plated, of the substrate when said porous member is pressed against the surface, to be plated, of the substrate held by said substrate stage under a desired pressure.

Claim 22 (Original) A plating apparatus according to claim 21, wherein said plating solution removing mechanism comprises a mechanism for making relative motion of at least two of the

substrate held by said substrate stage, said porous member, and the plating solution supplied between said anode and the surface, to be plated, of the substrate held by said substrate stage.

Claim 23 (Original) A plating apparatus according to claim 21, wherein said plating solution removing mechanism comprises a mechanism for vibrating at least one of the substrate held by said substrate stage, said porous member, and the plating solution supplied between said anode and the surface, to be plated, of the substrate held by said substrate stage.

Claim 24 (Original) A plating apparatus according to claim 21, wherein said plating solution removing mechanism comprises a mechanism for vibrating at least one of the substrate held by said substrate stage, said porous member, and the plating solution supplied between said anode and the surface, to be plated, of the substrate held by said substrate stage vertically to the surface, to be plated, of the substrate held by said substrate stage.

Claim 25 (Currently Amended) A plating apparatus according to claim 23-~~or~~ 24, wherein said mechanism for vibrating comprises a mechanism which utilizes an ultrasonic wave or a mechanism which uses a vibrator having an exciting coil.

Claim 26 (Currently Amended) A plating apparatus according to claim 23-~~or~~ 24, wherein said mechanism for vibrating comprises a piezo transducer.

Claim 27 (Currently Amended) A plating apparatus according to claim 23-~~or~~ 24, wherein said mechanism for vibrating utilizes pressure vibration.

Claim 28 (Original) A plating apparatus according to claim 21, wherein said plating solution removing mechanism comprises an anode chamber which houses said anode therein and has an open end portion closed by said porous member, and a pressure control unit for controlling a pressure of said anode chamber.

Claim 29 (Original) A plating apparatus comprising:
a substrate stage for holding a substrate;

a cathode unit having a seal member for hermetically sealing a peripheral portion of a surface, to be plated, of the substrate by contacting the peripheral portion of the surface, to be plated, of the substrate held by said substrate stage, and a cathode electrode which is brought into contact with the substrate to supply current to the substrate;

an electrode head disposed above said cathode unit so as to be movable up and down and having an anode and a porous member with water retentivity at upper and lower parts of said electrode head;

a plating solution supply unit for supplying a plating solution between said anode and the surface, to be plated, of the substrate held by said substrate stage; and

a power source for applying plating voltage between said cathode electrode and said anode;

wherein said porous member has a multi-layered structure in which at least two kinds of porous materials are laminated.

Claim 30 (Original) A plating apparatus according to claim 29, wherein said electrode head has a housing which houses said anode therein, and defines an anode chamber by closing a lower open end portion of said housing with said porous member.

Claim 31 (Original) A plating apparatus according to claim 30, wherein a plating solution suction pipe for sucking the plating solution into said anode chamber, a pressurized fluid introduction pipe for introducing a pressurized fluid into said anode chamber, and a power supply port for supplying power to said anode are attached to said housing.

Claim 32 (Original) A plating apparatus according to claim 29, wherein at least one space is formed between said porous materials which constitute said multi-layered structure.

Claim 33 (Original) A plating apparatus according to claim 32, further comprising:

a plating solution supply unit for discharging and supplying the plating solution to said space formed between said porous materials; and

a plating solution discharge unit for sucking and discharging the plating solution in said space.

Claim 34 (Original) A plating method comprising:

preparing a substrate having fine recesses for interconnects covered with a seed layer;
supplying a plating solution between a surface of the seed layer and an anode spaced from the seed layer at a certain interval through a porous contact member; and

plating the substrate by applying plating voltage between the seed layer and said anode;
wherein a change of the state of plating voltage applied between the seed layer and said anode, and a change of pressing state between said porous contact member and the seed layer are correlated.

Claim 35 (Original) A plating method according to claim 34, wherein said change of pressing state between said porous contact member and the seed layer is a change of pressure between said porous contact member and the seed layer.

Claim 36 (Original) A plating method according to claim 34, wherein said change of the state of plating voltage applied between the seed layer and said anode is intermittence of plating voltage applied between the seed layer and said anode.

Claim 37 (Original) A plating method according to claim 34, wherein said change of the state of plating voltage applied between the seed layer and said anode, and said change of pressing state between said porous contact member and the seed layer are correlated by applying said plating voltage when a pressure between said porous contact member and the surface of the seed layer is increased relatively, and by not applying said plating voltage when a pressure between said porous contact member and the seed layer is lowered more than the previous time relatively.

Claim 38 (Original) A plating method according to claim 34, wherein said change of pressing state between said porous contact member and the seed layer is a change of contact and non-contact between said porous contact member and the surface of the seed layer.

Claim 39 (Original) A plating method according to claim 34, wherein said change of the state of plating voltage applied between the seed layer and said anode, and said change of pressing state between said porous contact member and the seed layer are correlated so as to synchronize

contact between said porous contact member and the surface of the seed layer and application of plating voltage between the seed layer and said anode.

Claim 40 (Original) A plating method according to claim 34, wherein said change of the state of plating voltage applied between the seed layer and said anode, and said change of pressing state between said porous contact member and the seed layer are correlated so as not to apply plating voltage between the seed layer and said anode when said porous contact member is brought out of contact with the surface of the seed layer, and so as to apply plating voltage between the seed layer and said anode after an elapse of a certain period of time after said porous contact member is brought into contact with the surface of the seed layer.

Claim 41 (Original) A plating method comprising:

- preparing a substrate having fine recesses for interconnects covered with a seed layer;
- placing a porous member having water retentivity between the surface of the seed layer and an anode spaced from the seed layer at a certain interval; and
- plating the substrate by flowing current between the seed layer and said anode while filling a plating solution between the seed layer and said anode;

wherein while said porous member is pressed against the seed layer under a desired pressure, said plating is performed by flowing current between the seed layer and said anode.

Claim 42 (Original) A plating method according to claim 41, wherein said porous member is pressed against the seed layer under a desired pressure, and said porous member and the seed layer are moved relatively to each other before performing said plating by flowing current between the seed layer and said anode.

Claim 43 (Original) A plating method according to claim 41, wherein said flowing current between the seed layer and said anode is stopped, and said porous member is separated from the seed layer in the course of process.

Claim 44 (Original) A plating method comprising:

- preparing a substrate having fine recesses for interconnects covered with a seed layer;

placing a porous member having water retentivity between the surface of the seed layer and an anode spaced from the seed layer at a certain interval; and

plating the substrate by flowing current between the seed layer and said anode while filling a plating solution between the seed layer and said anode; wherein the plating solution existing between said porous member and the seed layer is removed before and after said porous member is pressed against the seed layer under a desired pressure, and then current is flowed between the seed layer and said anode.

Claim 45 (Original) A plating method according to claim 44, wherein said current is flowed only when said porous member is brought into contact with the seed layer.

Claim 46 (Currently Amended) A substrate processing apparatus comprising:
a loading/unloading station for carrying in and out a substrate;
a plating apparatus according to ~~any one of claims 1 to 33~~ claim 1;
a cleaning and drying apparatus for cleaning and drying the substrate; and
a transfer apparatus for transferring the substrate between said loading/unloading station, said plating apparatus, and said cleaning and drying apparatus.

Claim 47 (Original) A substrate processing apparatus according to claim 46, further comprising a polishing apparatus for polishing and removing unnecessary metal film formed on the surface of the substrate in said plating apparatus to planalize the surface of the substrate.

Claim 48 (Original) A substrate processing apparatus according to claim 46, further comprising a heat treatment apparatus for performing heat treatment of the substrate on which a metal film is formed in said plating apparatus.

Claim 49 (Original) A substrate processing apparatus according to claim 46, further comprising a bevel etching apparatus for removing a metal film attached or deposited on the peripheral portion of the substrate by etching.

Claim 50 (Original) A substrate processing apparatus according to claim 46, further comprising a monitor unit for monitoring at least one of a voltage value and a current value when said plating voltage is applied between said anode and said cathode electrode in said plating apparatus.

Claim 51 (Original) A substrate processing apparatus according to claim 46, further comprising a film thickness measuring device for measuring a thickness of the metal film deposited on the surface of the substrate.

Claim 52 (New) A plating apparatus according to claim 24, wherein said mechanism for vibrating comprises a mechanism which utilizes an ultrasonic wave or a mechanism which uses a vibrator having an exciting coil.

Claim 53 (New) A plating apparatus according to claim 24, wherein said mechanism for vibrating comprises a piezo transducer.

Claim 54 (New) A plating apparatus according to claim 24, wherein said mechanism for vibrating utilizes pressure vibration.

Claim 55 (New) A substrate processing apparatus comprising:
a loading/unloading station for carrying in and out a substrate;
a plating apparatus according to claim 6;
a cleaning and drying apparatus for cleaning and drying the substrate; and
a transfer apparatus for transferring the substrate between said loading/unloading station, said plating apparatus, and said cleaning and drying apparatus.

Claim 56 (New) A substrate processing apparatus comprising:
a loading/unloading station for carrying in and out a substrate;
a plating apparatus according to claim 21;
a cleaning and drying apparatus for cleaning and drying the substrate; and

a transfer apparatus for transferring the substrate between said loading/unloading station, said plating apparatus, and said cleaning and drying apparatus.

Claim 57 (New) A substrate processing apparatus comprising:
a loading/unloading station for carrying in and out a substrate;
a plating apparatus according to claim 29;
a cleaning and drying apparatus for cleaning and drying the substrate; and
a transfer apparatus for transferring the substrate between said loading/unloading station, said plating apparatus, and said cleaning and drying apparatus.